A Quantitative Survey of Cowslips in Cowslip Meadow, Biddenham

Introduction

On 28 March 2023 Biddenham Conservation Volunteers undertook a quantitative investigation aiming to estimate the *Primula veris*, (cowslip) population in Cowslip Meadow, Biddenham, Bedfordshire; accessed from Church End, Biddenham, Bedford MK40 4AR.

We were interested if cowslips are evenly dispersed or restricted to specific areas and not others. To test this we set a null hypothesis that "*the distribution of cowslips is even within the sample area"* and then measured the plants density by counting sample areas and estimating their population size.

If it becomes evident that density appears uneven, the null hypothesis is disproved. If this occurs, we could then introduce further investigations, in future. For example, using line transects to identify changes in primula distribution density that may be associated with identified biotic or abiotic factors.

Background

P. Veris in flower (l) and pre-flowering (r)

The common cowslip, *Primula veris* is a semi-evergreen perennial plant. Its height and spread are 25cm, it has a rosette of distinctly stalked, oblong-ovate leaves and upright stems bearing umbels of nodding, bell-shaped, fragrant rich yellow flowers about 1.5cm in width. They flower in the spring. Cowslips provide nectar and pollen for bees and other pollinators.

They thrive best in full sun or partial shade, but only if the soil is moisture retentive, and not waterlogged. They can be exposed or sheltered and are hardy. (1) Propagation is by seed or basal root cuttings; in a meadow setting propagation would be mainly by seed dispersal. Seeds germinate best on bare ground and often clumps of plants will form.

Seed germination is both temperature and light dependent and seeds require chilling during their dormancy. Waterlogging of the plants leads to leaf spots from the *Rumularia* fungus. Aphids, red spider mites, and caterpillars are the plants' major predators.(2) Deer and rabbits can cause grazing damage.

Local knowledge is that the meadow is annually blanketed with cowslips in a much greater density than you would find typically or on surrounding paths and verges in the village. When the meadow

was converted from arable farmland about 40+ years ago it was planted, so cowslips were introduced at that time.

The health of a cowslip population can be further investigated by looking at the ratio of Pin and Thrum varieties. These terms relate to the position of reproductive structures in the flower tubes. There are two versions, *Pin* where the female stigma (pollen trap) is at the top and *Thrum* when the male anthers (pollen sacs) are at the top. (That is a study for another day).

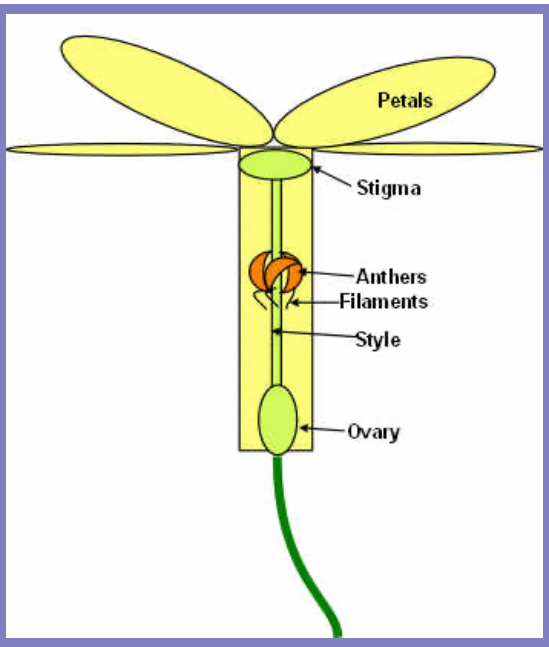


Diagram of a pin-eyed flower
cut from top to bottom
(longitudinal cross section)

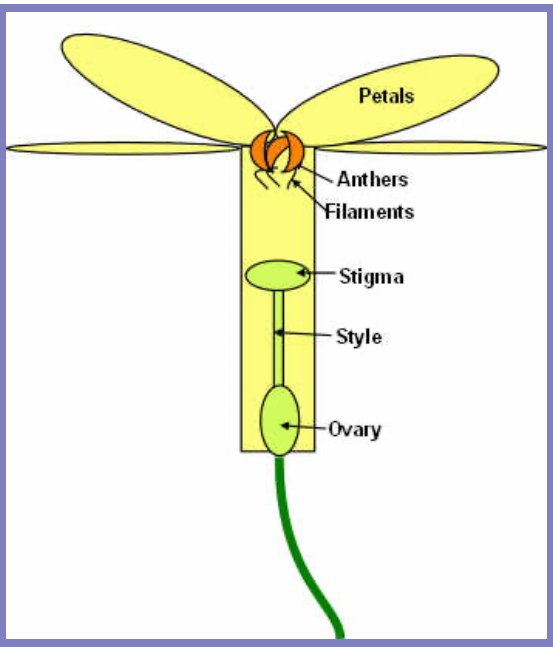


Diagram of a thrum-eyed flower
cut from top to bottom
(longitudinal cross section)

Long-tongued Insects visit the flowers in search of nectar, located at the base of the flower tube by the ovary; if visiting a pin-eyed flower, pollen sticks to the middle of its proboscis (tongue) from the anthers half-way down the flower tube. If it then goes to visit a thrum-eyed flower, the pollen is perfectly positioned to be wiped off on the stigma, in this case, halfway down the flower tube.

The reverse is true. If the insect visits a thrum-eyed flower, pollen is wiped onto the top of its proboscis as it seeks nectar. This is then transferred onto the stigma of the next pin-eyed flower which it visits. (3)

Quantitative Sampling Method

Determining the abundance of Cowslips involves random sampling within the meadow as it is too large an area (approx. 5.4 hectares) to count individual plants.

Randomly generating co-ordinates, using a computer programme, to set the position of quadrat sample sites is the best way to randomise the sampling. (4) However, dividing an area into sections and in each area going to different points and throwing the quadrat over the sampler's head backwards to determine a sampling point avoids visual bias in selecting sites. This was our approach, in each of 8 predetermined mapped areas, A to H (*The map used is at Appendix B*).

We used a square frame quadrat, 0.5m x 0.5m, and counted the number of cowslips found within the frame. This is repeated at many sites across the meadow, as time and volunteer interest permitted.

In a large meadow, the more samples we take the more closely the result will represent the actual population size.

The density of cowslips in the whole meadow is then calculated using the formulae:

Density of species = Number of Plants ÷ Area

[*E.g., if 140 plants were counted in ten quadrats then their density in the sampling area is:*
Density = 140 ÷ number of quadrats used x quadrat dimensions (10 x 0.5m x 0.5m)
Density = 140 ÷ 2.5m^2
Density = 56 per m^2.
The result in this example is: Density = 56 plants per square metre] (5)

Looking at a species' density assumes few factors affect its distribution and cowslips are evenly spread. If there is a clear change in distribution in some places, then a transect (a line) can be set out, with quadrats placed at 5 or 10m intervals along its length to sample and investigate the distribution along that line.

A transect could investigate and quantify the changes associated with say, less daylight as you transition from meadow into woodland, or the effect of trampling on either side of a path or question does drainage (varying soil moisture levels) down a slope affect plant distribution?

Data Collection

Each sampler records the number of *P. veris* plants observed in the quadrat at each quadrat and records this either on a data sheet, or digitally:

Date: _____ Sampler _____ Meadow area number _____

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* present										

The collected data is pooled for the entire group and analysed.

Calculations

(Raw data sheets are located at Appendix A; the sampling was carried out on 28 March 2023, am)

We use the formulae:

Density = no of plants counted divided by (number of quadrats used x quadrat area)

Applying the formulae to the data we calculate the density of plants per metre squared:

Area	***count / area***	**plants per m^2**
A	295 / (45 x 0.5m x 0.5m)	26.2
B	226 / (15 x 0.5m x 0.5m)	60.26
C	301 / (30 x 0.5m x 0.5m)	40.13
D	291 / (20 x 0.5m x 0.5m)	58.2
E	242 / (20 x 0.5m x 0.5m)	48.4
F	195 / (30 x 0.5m x 0.5m)	26
G	117 / (30 x 0.5m x 0.5m)	15.6
H	19 / (15 x 0.5m x 0.5m)	5

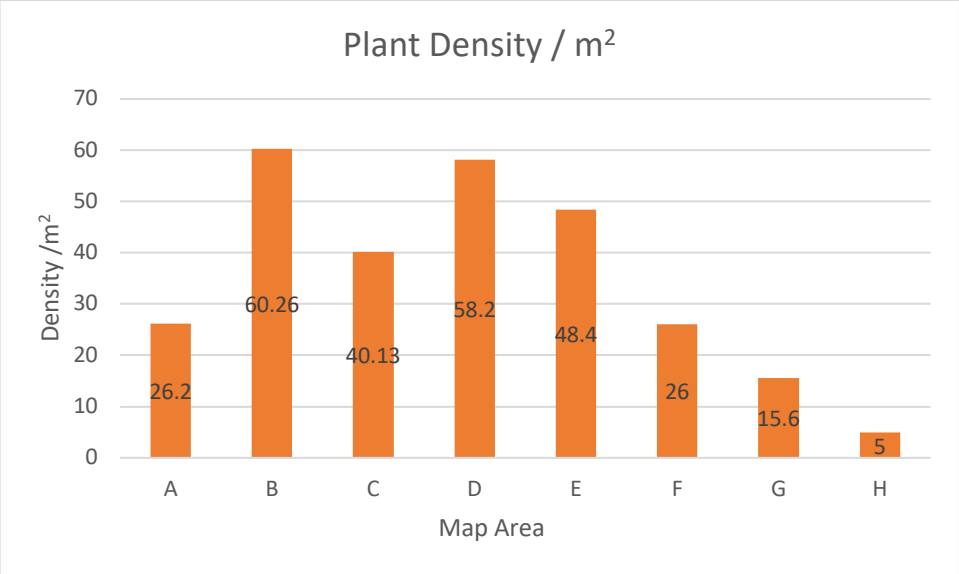
Results

In early spring cowslips are easily spotted and identified as they precede the growth of most competitors. Their rosettes are distinctive and compared to spotting other species they are visible

and not hidden. The numbers per quadrat were generally easy to count. There is therefore high confidence in the accuracy of counting and reliability of the data.

Density of Cowslips per m^2 in different meadow areas, A-H *(see map in Appendix B)*:

Meadow Area	***Plant Density / m^2***
A	26.2
B	60.26
C	40.13
D	58.2
E	48.4
F	26
G	15.6
H	5
Total	279.79
Mean (Total/8)	**34.97**



Observations

Volunteers noted that within the eight sample areas there wasn't a uniform distribution. This is reflected in the data too. Less plants were associated with footpaths, patches covered in moss, and in map areas F and G, which had regions of being waterlogged. In the map areas E and F, where a vegetation tract had not been mown last autumn, there was still thick ground vegetation, which had not rotted back over winter and significantly less cowslips were observed here.

There were signs of rabbit grazing of primulas in area G, this was not noted elsewhere.

Analysis

We sampled 235 quadrat sites across 8 areas to subdivide the 5.4 hectares, representing a sampling of 58.7m^2. In those sites, we counted 1,686 cowslips. We calculated the mean density of cowslips in the meadow as being 34.97 plants per m^2. Rounded up to 35m^2.

The distribution wasn't even within any one area, ranging from zero to 52 in a quadrat. Nor was it even across the meadow, even ignoring the flooded areas F and G. It ranged from 5 plants per m^2 in area G to 60.26 plants per m^2 in area B. This disproves our Null Hypothesis.

There were 49 quadrats, or 4.79%, of the samples where no cowslips were present, the greater number of zero counts were at the northern end of the meadow, in areas G and H.

Discussion

The high density observed in this survey is consistent with cowslips being introduced by sowing/planting, presumably in tandem with sowing of other meadow plant seeds. The uneven distribution within the meadow reflects the ongoing competition over time with other species and the effects of both biotic and abiotic factors on cowslip survival and selection. The density is very high for a non-cultivated specie.

The present findings can be used to benchmark future surveys to see how well cowslips are doing over time as climate change and other influences affect local plant communities.

Summary

A quantitative investigation of the density of *P. vergis* in the Cowslip Meadow, Biddenham showed a mean density value of 34.97 plants per square metre; rounded up to 35 plants per m^2. The distribution was uneven with no presence in some places within the meadow especially in marshy areas and where moss dominates.

References

1. Royal Horticultural Society website. *Primula Veris* accessed 3.2.2023 (https://www.rhs.org.uk/plants/13892/primula-veris-(pr)/details)
2. Allen Hammer, P., *Introduction to Floriculture.* 1992 accessed 7.2.2023 (https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/primula)
3. Devon Action Diversity Plan (http://www.countrysideinfo.co.uk/devon_bap/prim2.htm)
4. Malmsbury Science *Quadrat Sample Technique* (YouTube video) (https://www.youtube.com/watch?v=RhMOCxXcDrQ) accessed 20.3.2023.
5. Reiss, M J. and Chapman, J L. *Ecology and Conservation* p 29-30. University Press, Cambridge. ISBN 0 521 42158 6.

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Appendix A ~ Raw Data

Survey of the Common Cowslip, *Primula veris*

Each sampler recorded the number of P. veris plants observed in the quadrat at each sampling site and recorded this on a data sheet:

Date: 28.3.23 Samplers: Pat & Lois Meadow zone number: **A** (south end)

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	0	1	6	2	0	14	3	10	0	14

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of *P. veris* plants	14	17	20	15	14	8	0	4	0	17

Quadrat number	21	22	23	24	25	26	27	28	29	30
No of *P. veris* plants	15	11	1	6	7	8	8	7	2	0

Quadrat number	31	32	33	34	35	36	37	38	39	40
No of *P. veris* plants	0	5	11	12	9	4	12	2	2	8

Quadrat number	41	42	43	44	45	***Totals***	45
No of *P. veris* plants	4	1	2	3	7		295

Date: 28.3.23 Sampler: Jane Moore Meadow zone number: **B**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	4	2	11	13	11	7	4	16	15	0

Quadrat number	11	12	13	14	15	**totals**	15
No of *P. veris* plants	3	8	16	8	9		226

Date: 28.3.23 Samplers: Gilly & Stuart Meadow zone number: **C**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	0	2	12	0	0	8	6	6	4	2

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of *P. veris* plants	15	2	7	10	26	29	16	41	26	21

Quadrat number	21	22	23	24	25	26	27	28	29	30
No of *P. veris* plants	19	3	6	2	6	6	9	8	3	6

Quadrat number	**totals**	30
No of *P. veris* plants		301

Date: 28.3.23 Samplers: Val & Julia Meadow zone number: **D**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	5	3	5	10	10	8	1	19	11	7

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of *P. veris* plants	0	2	12	12	10	17	8	22	23	41

Quadrat number	**totals**	20
No of *P. veris* plants		291

Date: 28.3.23 Samplers: Chris & Jonathan Meadow zone number: **E**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	29	27	5	6	4	0	7	0	2	0

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of *P. veris* plants	24	1	52	52	25	0	6	0	0	2

Quadrat number	**totals**	20
No of *P. veris* plants		242

Date: 28.3.23 Sampler: NRO Meadow zone number: **F**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	15	0	0	0	3	16	8	6	4	6

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of G*P. veris* plants	14	8	3	4	3	10	0	2	0	0

Quadrat number	21	22	23	24	25	26	27	28	29	30
No of *P. veris* plants	4	13	12	8	11	11	2	20	10	2

Quadrat number	**totals**	30
No of *P. veris* plants		195

Date: 28.3.23 Samplers: Gilly & Stuart Meadow zone number: **G**

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	0	0	0	0	0	0	2	0	0	21

Quadrat number	11	12	13	14	15	16	17	18	19	20
No of G*P. veris* plants	1	0	2	6	1	8	0	0	24	9

Quadrat number	21	22	23	24	25	26	27	28	29	30
No of *P. veris* plants	8	0	2	0	0	0	23	9	0	1

Quadrat number	**totals**	30
No of *P. veris* plants		117

Date: 28.3.23 Sampler: Jane Moore Meadow zone number: **H** (north end)

Quadrat number	1	2	3	4	5	6	7	8	9	10
No of *P. veris* plants	1	1	0	7	1	0	0	0	0	0

Quadrat number	11	12	13	14	15
No of G*P. veris* plants	0	0	9	0	0

Quadrat number	**totals**	15
No of *P. veris* plants		19

Appendix B – Map of Cowslip Meadow, subdivided into areas A-H

End.